

DRAFT

Specification of the High Energy Spectrometer Dipole Magnets for the ILC Test Facility at the Fermilab New Muon Lab

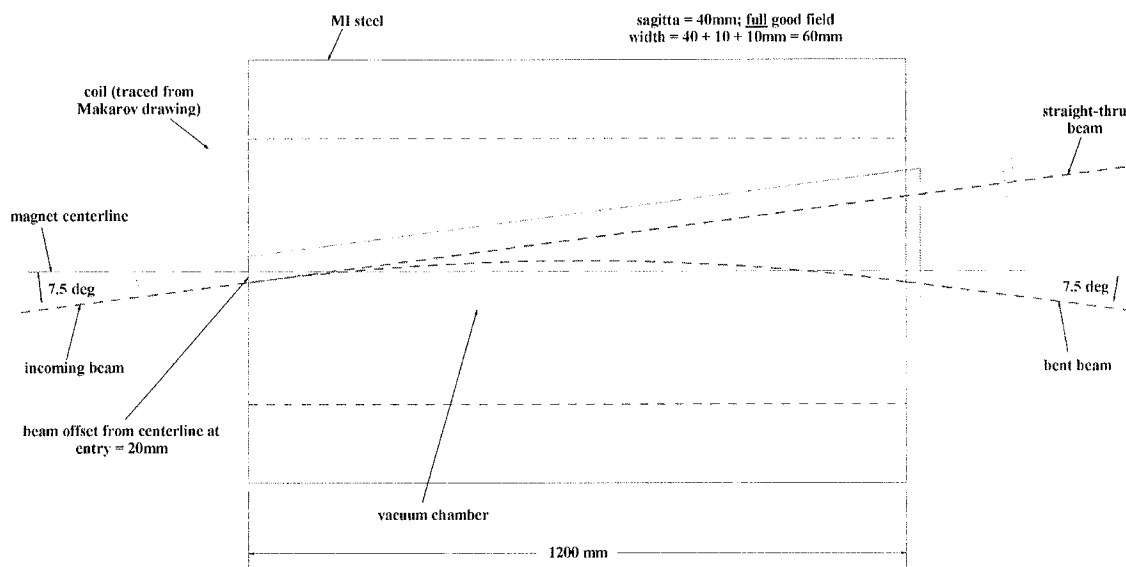
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Introduction

Fermilab seeks proposals for the design and fabrication of four identical dipole electromagnets for use in the High Energy Spectrometer for the ILC Test Facility at the Fermilab New Muon Lab. Fermilab will provide the magnet half cores and, optionally, the conductor. The vendor will design the coils and the balance of the magnet assembly, fabricate the coils, and assemble the magnets.

The magnet aperture is determined by the requirement that the magnets must accommodate a vacuum chamber (provided by Fermilab) that will transport a beam of electrons bent by the magnet, a beam of uncharged particles passing straight through the magnet, and the synchrotron radiation from the bending electrons. See the sketch below for the dimensions. The magnet must split (only bolted connections) for the installation of the vacuum chamber at Fermilab. The magnet is straight. The transverse outside dimensions of the magnet are not tightly constrained. The longitudinal dimensions of the core and coils are less flexible, limited on the high side by geometrical constraints and limited on the low side by a desire to restrict the bend field.

15 deg dipole for NML HE beamline



The magnet will operate DC at selected excitations between the values specified in the magnet parameters table below. The response to excitation current need not be linear, but the field uniformity must be maintained. In providing the cores, Fermilab takes responsibility for the magnetic performance.

To meet the performance requirements, the coils must be able to handle between 2,700 and 68,000 Ampere-turns of current. Included in this package is a conceptual drawing of the magnet and with a coil package based on conductor currently in possession of Fermilab. The coil cross section is determined by the conductor dimensions (including reasonable tolerances for straightness), insulation requirements, and the inner dimension of the core. The maximum magnet length is specified, which we expect to be determined by the coil package length. Alternate configurations may be proposed.

The coils must be insulated and vacuum impregnated with a suitable epoxy formula as specified by Fermilab on drawings MA-351120, MA-116500, MA-116502, MA-116503, and MA-331443. Alternate proposals may be considered, but must be approved by Fermilab prior to use.

The water and electrical manifolding may be located either at the end of the magnet or on the side, but may not interfere with the disassembly/assembly of the core for installation of the beam vacuum chamber or with the beam vacuum chamber itself.

Note that the coil dimension is slightly larger than the coil dimension at the base of the pole, necessitating a spacer between the coil and core. The coils should be anchored to the cores in the middle, mechanical support is expected, consistent with the requirement that the magnet be subject to disassembly for vacuum chamber installation.

Vendor may request modification to the exact geometry of the chamfers in the core end plates that provide relief for the coil radius. Vendor may request Fermilab to provide drilled and tapped holes in the core for attaching supports for the manifolding.

Request for Proposal

We invite you to make your proposal for the fabrication of the High Energy Spectrometer Dipole Magnets as set forth below. Please quote the above magnets according to the schedule detailed below. Except as listed under Fermilab Supplied Parts, the subcontractor shall provide all supervision, labor, necessary materials, tooling fixtures, consumable supplies, engineering, inspection, testing equipment, and all other services needed to meet the requirements of this Scope of Work. All necessary facilities for the design, fabrication, and testing of the coils and magnets shall be the responsibility of the subcontractor. All prices are to be DDP Fermilab, Batavia, Illinois.

Fermilab Supplied Parts

In the interest of reducing the delivery time, Fermilab intends to offer the supply of certain components, as indicated. Bidders may at their option, supply their own materials.

1. Magnet cores per drawing ME-458001 (Sheet 1, 2, 3 of 3.)

2. Conductor MA-116076. (The copper has been stored inside, however the vendor is responsible for adequate surface preparation which may include grit blasting to remove all contaminants.)
3. Fiberglass insulation as per drawings (1"), MA-116511, (2") MA-225574.
4. Alignment features per drawing MA-xxxxxx.

Deliverables

Vendor to deliver

1. Design of magnet coils for Fermilab approval. Coils may use Fermilab conductor and parameters listed or vendor may propose an alternative design to provide the required magnet parameters, without internal braze joints.
2. Design of complete magnet for Fermilab approval. Water and power connections must be provided with suitable mechanical support. Vendor may drill and tap holes or weld onto the solid steel end pack or the tie plates. Placement of the alignment fixtures will be negotiated after power and water connections and support are determined.
3. Engineering notes demonstrating adequacy of lifting point design, sizing of electrical bus and flags, and water cooling circuits.
4. Four magnets, with certified good insulation providing acceptable electrical performance, water leak - tight joints, and specified water flow.
5. Two spare magnet coil packages (one upper and one lower).
6. Freight for magnet cores from Fermilab to vendor and for complete magnets and spare coils from vendor to Fermilab.
7. Finished travelers documenting fabrication steps and in-process and final mechanical and electrical measurements.

Manufacturing Plan

The subcontractor shall submit a manufacturing plan to Fermilab for acceptance by the date specified in the contract. The plan shall identify and describe all aspects of work to be executed from the point of design work through delivery of the magnets. The Manufacturing Plan shall include and document of the following stages:

- Parts Procurement
- Coil Design
- Coil Winding
- Coil Impregnation
- Coil Cleanup
- Coil Testing
- Magnet Assembly

Fermilab must approve the manufacturing plan prior to its use by the subcontractor.

Quality Assurance Plan

The subcontractor shall submit a Quality Assurance (QA) Plan to Fermilab for approval by the date specified in the subcontract. The plan shall ensure that each item

offered for acceptance conforms to the requirements herein. As a minimum requirement the QA plan shall include:

- Proposed layout of Travelers. Details of each step of the fabrication process must be described in a traveler-type document, which must be made available to Fermilab as a MS Word file and be approved before the fabrication starts. A copy of the traveler document must be provided for each magnet assembly shipped to Fermilab.
- QA plan must include methods for inspection and dimensional control of mechanical parts and subassemblies including description of the measuring equipment, sequence and frequency of inspection, methods for defect/flaw determination, criteria for rejection of parts including corrective action and plan for record keeping.
- QA plan must include a description of the method and equipment used for coil winding and epoxy impregnation.
- QA plan must include a procedure for brazing and testing the braze joints of the coils.
- QA plan must include a description of the HV test and a pulsed ringing test.
- QA document must include Non-Conformance reporting. Discrepancies shall be reported in Non-Conformance Reports and submitted to Fermilab for disposition. Work shall be placed on hold until the corrective action has been accepted by Fermilab.

Fabrication Schedule and Shipping

Fermilab will provide the cores for pick-up starting four months after the contract is awarded. Delivery of the first magnet is requested five months after the contract is awarded. Delivery of subsequent magnets is requested at the rate of about one magnet every month until the full quantity is delivered. Packaging design is subject to review and approval by Fermilab, but approval shall not relieve the contractor of any responsibility for damage during transit due to improper packaging or handling.

Certification and Authorization to Ship

The contractor shall furnish a certificate of compliance to Fermilab that the magnets were manufactured and inspected in accordance with the requirements of this scope of work and that the magnets were found to meet the requirements (except as documented in Fermilab-accepted Non-Conformance Reports). Shipment of the completed magnet assemblies shall not occur until all inspections identified in the contract have been completed and the Traveler has been received and accepted by Fermilab. Authorization to ship the magnets shall be communicated in writing by Fermilab's authorized representative within 10 calendar days. On receipt of the magnets and coils, Fermilab will perform any tests deemed necessary to ensure that the magnets conform to the requirements.

Evaluation of Proposals

Proposals will be evaluated on the basis of technical merit and cost. Factors in the technical merit evaluation will be... If vendor-proposed substitutions for Fermilab-

supplied materials are accepted, credit will be given in the cost evaluation for the book value of the materials that Fermilab does not need to supply.

Magnet Performance Parameters (for information only)

Parameter	Value	Units	Tolerance	Comments
Magnet gap	65	mm		Gaps between upper and lower core halves shall not exceed 0.005"
Length, steel	1.2	m	+/- 2 mm	Core tolerances are responsibility of Fermilab
Magnetic field, maximum	1.29	T		
Magnetic field, minimum	0.054	T		
Good field width	60	mm		0.3 % variation from central field

Magnet/Coil Parameters (requirements)

Parameter	Value	Units	Tolerance	Comments
Magnet length	1.540	m	+/- 2 mm	Maximum extent of any component
Coils per pole	1	each		Pancake type coil
Current, maximum	70,000	Ampere-turns		DC
Conductor				Water cooled with no internal joints.
Power flags	2	Each		One in, one out, with bolt holes in pattern of Fermilab Drawing xxxx-Mx-xxxx
Leakage current	<5	μA		At 500 V
Water manifold				Coils must be electrically insulated from manifolds with non-conductive hoses (Parker type 518A-8 or equivalent) or PEEK insulators.
Water fittings	2	Each		One inlet, one outlet, NPT male, sized appropriately

Hydrostatic test	500	psi		No pressure loss for 30 minutes
Whole magnet water flow	8	gpm		At 60 psi differential pressure
Lifting eyes	4	Each		On top, 1"- 8 with shoulder
Alignment features	12	Each		Provided by Fermilab, welded to core at mutually agreeable locations, four on top, four on bottom, two on each side
Core finish	Marlin Blue			5520-MA-318690 Over appropriate primer
Bolts and fittings				All nuts, bolts, fittings, threads, etc. to be ASME B18.3 or SAE J429

Magnet/Coil Parameters (conceptual design)

Parameter	Value	Units	Tolerance	Comments
Conductor (90' coils)	0.625 x 0.825 x .250 hole	in		Water cooled with no internal joints. 0.250" dia center hole.
Pancakes per coil	2	Each		One pancake type #1 and one pancake type #2, internally or externally connected in series with common ground insulation, potted together
Pancake #1 turns per layer	7	Each		Two layers per pancake, one water circuit per layer
Pancake #2 turns per layer	8	Each		Two layers per pancake, one water circuit per layer
Resistance	~12.5	mOhm		Per magnet
Voltage	~14	V		Per magnet